TRANSMIT/RECEIVE SWITCH FOR AN RF TRANSCEIVER

BACKGROUND OF THE INVENTION

FIELD OF THE INVENTION

[0001] The invention relates to a transceiver for radio frequency signal, more particularly to respective switching of a receive branch or a transmit branch to an antenna. Such a transceiver can be used in a wireless local area network or in any other suitable wireless system.

DESCRIPTION OF THE RELATED ART

[0002] Transceivers for wireless systems such as wireless LANs, cellular or cordless telephone systems are well known in the art. In one type of transceivers, a transmit branch and a receive branch are respectively switched to an antenna, when the transceiver is in a transmit mode or in a receive mode, respectively. Reception or transmission may be in the same band or in separate bands. For respective switching of the transmit branch or the receive branch to the antenna, in known transceivers, a first switch is provided between an output stage of a power amplifier comprised in the transmit branch and an antenna feed point, a second switch is provided between the antenna feed point and an input stage of a low noise amplifier comprised in the receive branch.

SUMMARY OF THE INVENTION

[0003] It is an object of the invention to provide switching of a transmit branch in a transceiver to an antenna feed point that also under high voltage output signals delivered by a transmit power output stage causes no component break through or other problems.

[0004] To this end the transceiver comprises a transmit branch that is coupled to an antenna feed point, a receive branch comprising a first network with an output node and with an input node that is coupled to the antenna feed point, the first network being configured such that in a transmit mode of said transceiver said input node is switched as an open circuit by switching said output node as a short circuit.

[0005] The inventor had realized that although in principle prior art transmit/receive switching networks that comprise MOS devices such as NMOS devices could function without malfunctioning when high voltages at the output stage of the transmit power amplifier needed to be generated, that there might be circumstances under which such NMOS devices could still break through. One such circumstance could be breaking off of the antenna, causing, due to severe antenna impedance mismatch, a sharp voltage increase at the antenna feed point. The inventor further realized that although there might be solutions to such break through problems, for low cost applications such as home networks, it would be highly desirable to provide a solution that allows full integration of the transmit/receive antenna switch, with minimal use of external components. The invention provides such a solution, at least for the receive antenna switch, by creating an open circuit at the network side that is coupled to the antenna feed point, seen from the antenna feed point, when the transceiver is in transmit mode, such an open circuit being created through impedance transformation by a switch at the other side of the network without imposing any problems on the switch itself, even when using a non-ideal transformation network. Or, stated otherwise, impedance transformation as of the invention from a low voltage node to a high voltage node allows use of switching components such as NMOS devices at the output node of the network with low break through voltages. In this respect, the transmit output stage may generate a high voltage in the order of 5-10 volts typically causing no higher worst case voltage at the output node than in the order of 1 volt. Herewith, the antenna receive switch can be very easily integrated in an integrated circuit.

[0006] In an embodiment, the first network may be an LC-network. In another embodiment, the first network may be a 1/4-Lamda transmission network.

[0007] In embodiments, in the transmit mode, the output node may be switched to a low or zero voltage by an NMOS device or a Reed relays coupled between the output node and ground.

[0008] In another embodiment, in the transmit mode, the output node may be switched to low or zero voltage by a transistor, e.g. a MOS device, that is coupled in a feedback path of a low noise amplifier in the receive branch. In such an embodiment, feedback prevents change of input voltage at an input of the low noise amplifier so that the input voltage is

effectively kept to a zero voltage level while still the low noise amplifier can draw current. Herewith, effectively, the input of the low noise amplifier acts as a short circuit when the transceiver is in the transmit mode.

[0009] In an embodiment, a tank circuit that is coupled to a transmit power output transistor is directly coupled to the antenna feed point. In this embodiment, when the transceiver is in receive mode, the transmit power output transistor is simply switched off so that its output is high-ohmic. This might cause some losses, when the transceiver is in receive mode, but such losses are typically low, as shown by simulations, no more than in the order of 1 dB. This solution allows very easy integration of the full transmit/receive antenna switch in an integrated circuit. This is because the transmitter, the receiver and the transmit/receive antenna switch can be integrated using the same RF silicon process, such as a QUBIC3 process.

[00010] In another embodiment, the tank circuit is coupled to the antenna feed point by a MOS switch between the tank circuit and the antenna feed point. Also in this embodiment, the transmit power output transistor is switched off when the transceiver is in receive mode. Although in this embodiment the transmit antenna switch part is not so easy to integrate in an integrated circuit, reduced loss is obtained when the transceiver is in receive mode. This is because a different RF silicon process is needed to implement the transmit antenna switch part, to prevent break through, such as an RF GaAs process.

BRIEF DESCRIPTION OF THE DRAWING

[00011] Figure 1 is a diagram of a transceiver according to the invention.

[00012] Figure 2 is circuit diagram of an input stage of a low noise amplifier including a switch according to the invention.

[00013] Figure 3 is an embodiment of network of the invention.

[00014] Figure 4 shows a transmit antenna switch part in a transmit/receive switch according to the invention.

[00015] Throughout the figures the same reference numerals are used for indicating the same elements.

DESCRIPTION OF THE DETAILED EMBODIMENTS

[00016] Figure 1 is a diagram of a transceiver 1 according to the invention. Such a transceiver 1 may be part of an apparatus such as a wireless network apparatus, a cell phone, a cordless phone, a PDA, a PC with a wireless module, or the like. The transceiver 1 may also be included in a radio frequency transceiver module to be used in an apparatus or system, or a combination of devices. The transceiver 1 comprises a transmit branch Tx and a receive branch Rx. In transmit branch Tx, a transmit power transistor 2 is shown that is coupled to a transmit tank circuit 3 comprised of an inductor 4, a capacitor 5 and a capacitor 6. The tank circuit 3 is coupled to an antenna feed point 7 to which an antenna 8 is or can be connected. In receive branch Rx, a low noise amplifier (LNA) 9 is shown that is coupled to the antenna feed point 7 via a network 10. In the shown embodiment, network 10 comprises a capacitor 11 that is coupled between an input node of network 10 and ground, an inductor 12 between antenna feed point 7 and an output node of network 10, and an NMOS switch 13 between the output node and ground. Transceiver 1 further comprises control means 14 to control the transceiver 1 to adopt a transmit mode or a receive mode, respectively. In transmit mode, NMOS switch 13 switches the output node to ground, i.e., the output node is short-circuited, thereby, through network 10 that performs impedance transformation, causing the input node to become an open circuit. LC-network 10 has two purposes, first to isolate receive branch Rx from the antenna 8 by creating a short circuit at the output which is seen as an open circuit at the input, and second to transfer the antenna signal to an input of low noise amplifier 9 by opening the short at the output. The ratio of the LC can be used to match the antenna impedance, typically 50 Ohms, to the input impedance of LNA 9.

[00017] Figure 2 is circuit diagram of an input stage 20 of a low noise amplifier including a switch 21 according to the invention. Input stage 20 comprises cascoded transistors 22 and 23 of which transistor 23 is an input transistor that is coupled to inductor 12 shown in Figure 1, and of which transistor 22 is an output transistor. In this embodiment, through a feedback mechanism whereby transistor 21 closes a feedback path when transceiver 1 is in transmit mode, the input voltage of low noise amplifier input stage 20 is kept low, zero or close to zero, so that the input impedance of input stage 20 is low or zero. Herewith, effectively a short circuit situation is obtained. Further

shown in Figure 2 are a DC-blocking capacitor 24, a load resistor 25, a current source 26, and a capacitor 27.

[00018] Figure 3 is an embodiment of network 10 of the invention. In this embodiment, network 10 comprises a 1/4-Lamda transmission line 30, embodied as a micro-strip line, and a switch 31 to ground. Switch 31 may be an RF Reed relays. Transmission line 30 is a bi-directional element that transforms a short circuit to an open circuit and vice versa. Network 10 has two purposes, first to isolate receive branch Rx from the antenna 8 by creating a short circuit at the output which is seen as an open circuit at the input, and second to transfer the antenna signal to an input of low noise amplifier 9 by opening the short at the output. The impedance of the micro-strip line can be used to match the antenna impedance, typically 50 Ohms, to the input impedance of LNA 9.

[00019] Figure 4 shows a transmit antenna switch part in a transmit/receive switch according to the invention comprising an NMOS transmit switch 40. With transceiver 1 in receive mode with transistor 2 switched off, switch 40 is open thereby blocking reception energy to enter transmit branch Tx.

[00020] In view of the foregoing it will be evident to a person skilled in the art that various modifications may be made within the spirit and the scope of the invention as hereinafter defined by the appended claims and that the invention is thus not limited to the examples provided. The word "comprising" does not exclude the presence of other elements or steps than those listed in a claim.